MS4 Modeling

Challenges and Solutions in Creating Madison's Model

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The Journey to Come

- Background
- Modeling approach
  - Input files
  - Pond plan discovery and digitization
  - Watershed delineation
  - Land use analysis/Standard Land Use files
  - Freeways/non-Madison/agricultural contributing areas
  - Leaf management
- Results
- Problems and solutions

Background: Why Undergo This Effort?

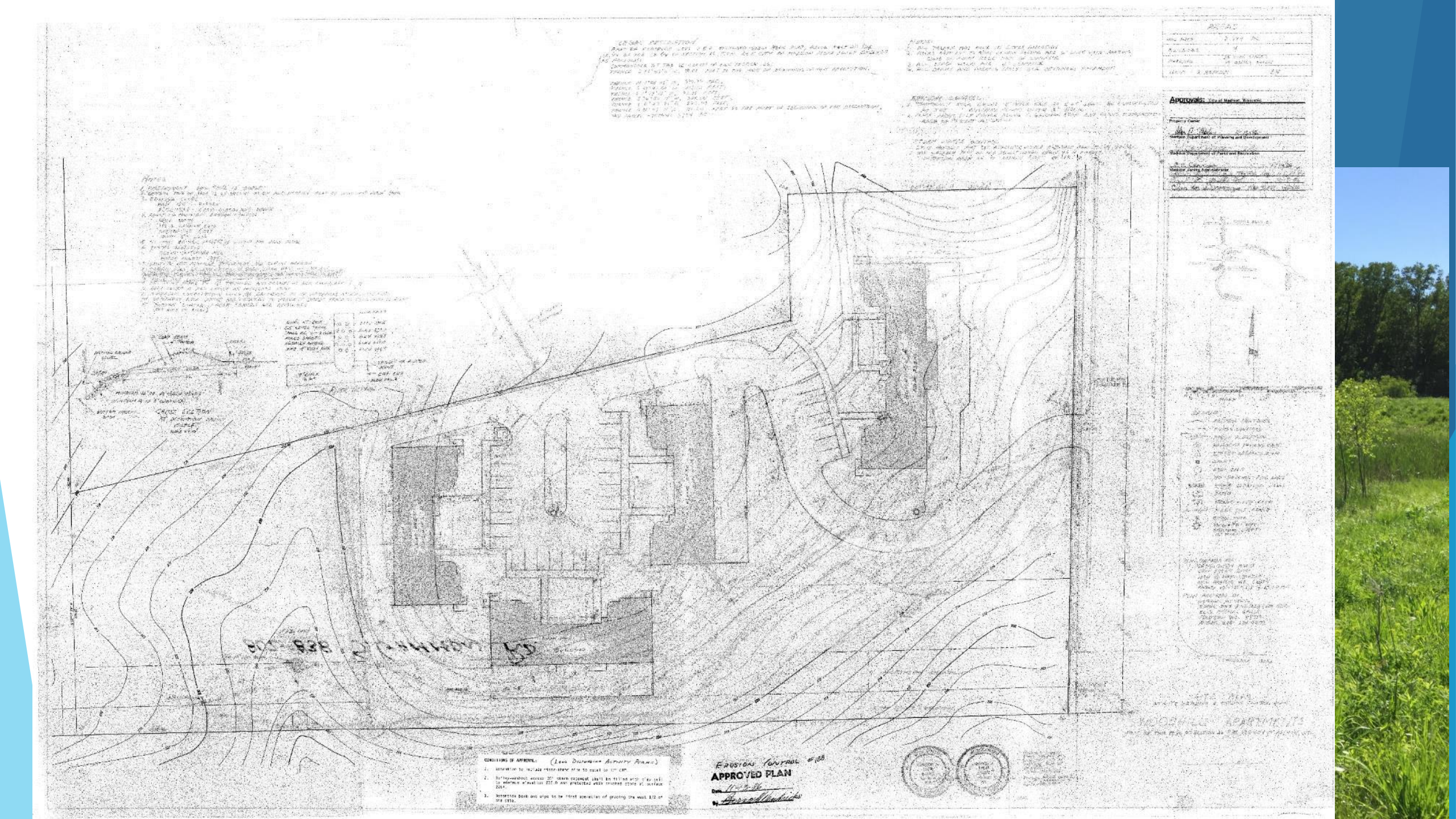
- City of Madison holds an MS4 General Permit
  - Initial requirement (Mar 2008): 20% TSS reduction in storm water from no controls
  - Mar 2013: 40% TSS reduction from no controls
- Rock River TMDL (completed in 2011)
  - All but one City of Madison watershed falls within Rock River Basin
  - Baseline condition for TMDL: 40% TSS reduction from no controls
  - City of Madison is a participant in Madison Metropolitan Sewerage District's (MMSD) Adaptive Management Program
  - Modeling results will help City decide how much total phosphorus (TP) to buy through Adaptive Mangement

Background: Why WinSLAMM?

- 2011 City of Madison modeling effort: P8 calibrated to WinSLAMM
- 2016-2017 modeling effort: WinSLAMM
  - WinSLAMM is well-recognized and understood by WDNR reviewers
  - WinSLAMM undergoes regular updates to improve the program and include new technologies
  - WinSLAMM's development and support team is local and responsive
  - Standard Land Use files

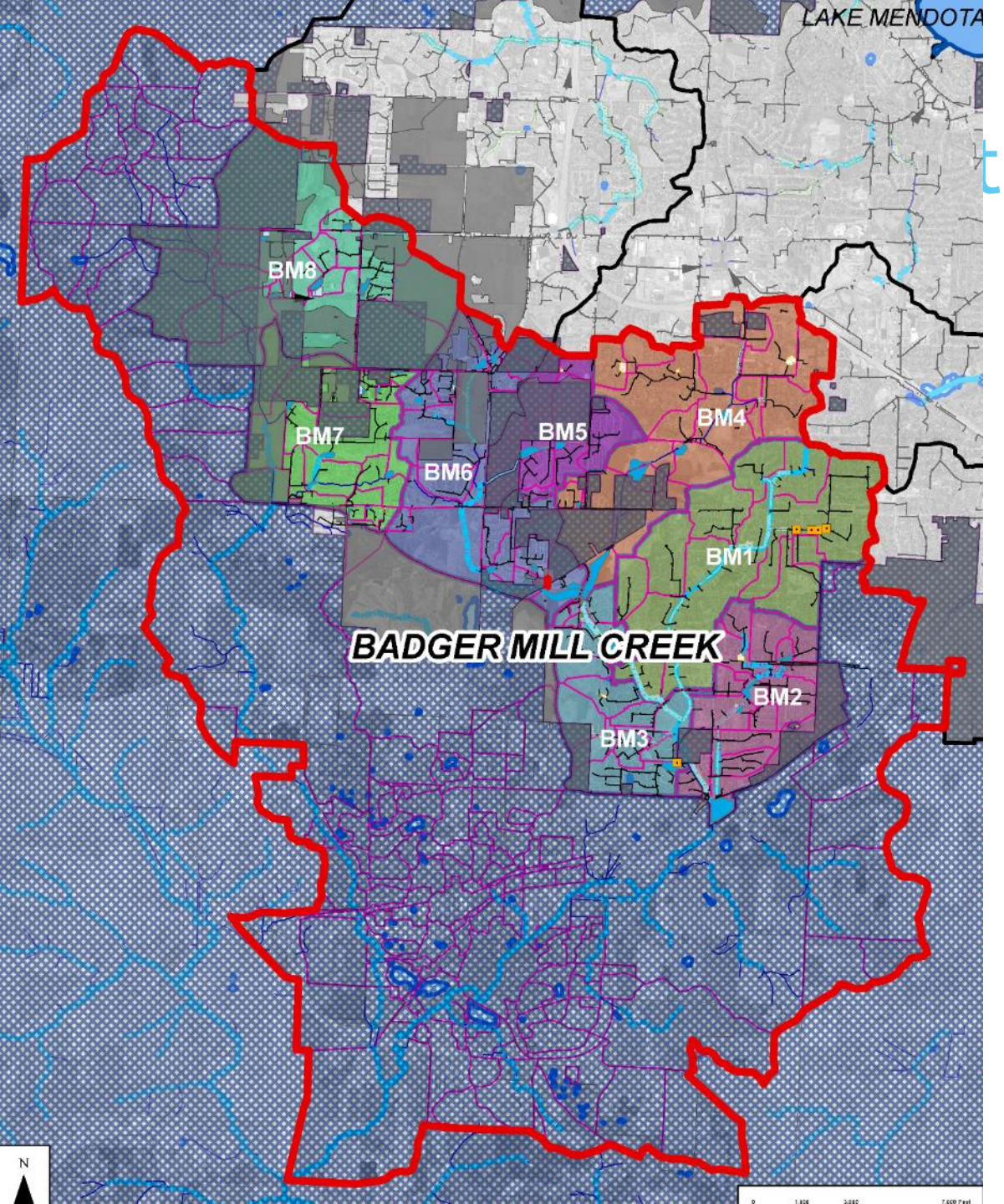
Modeling Approach: Input File

Parameter		Input File
Rain File		C:\WinSLAMM Files\Rain Files\WisReg - Madison WI 1981.RAN OR WisReg – Madison Five Year Rainfall.RAN
Pollutant Probability Distribution File		C:\WinSLAMM Files\WI_GEO03.ppdx
Runoff Coefficient File		C:\WinSLAMM Files\WI_SL06 Dec06.rsvx
Particulate Solids Concentration File		C:\WinSLAMM Files\v10.1 WI_AVG01.pscx
Street Delivery File	Residential LU	C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
	Institutional LU	C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
	Commercial LU	C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
	Industrial LU	C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
	Other Urban LU	C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
	Freeways	C:\WinSLAMM Files\Freeway Dec06.std
Source Area PSD and Peak to Average Flow Ratio File		C:\WinSLAMM Files\NURP Source Area PSD Files.csv
Source Area Particle Size Distribution File		C:\WinSLAMM Files\NURP.cpz


Approvals:
APPROVED PLAN

Modeling Approach: Treatment Practices/Devices

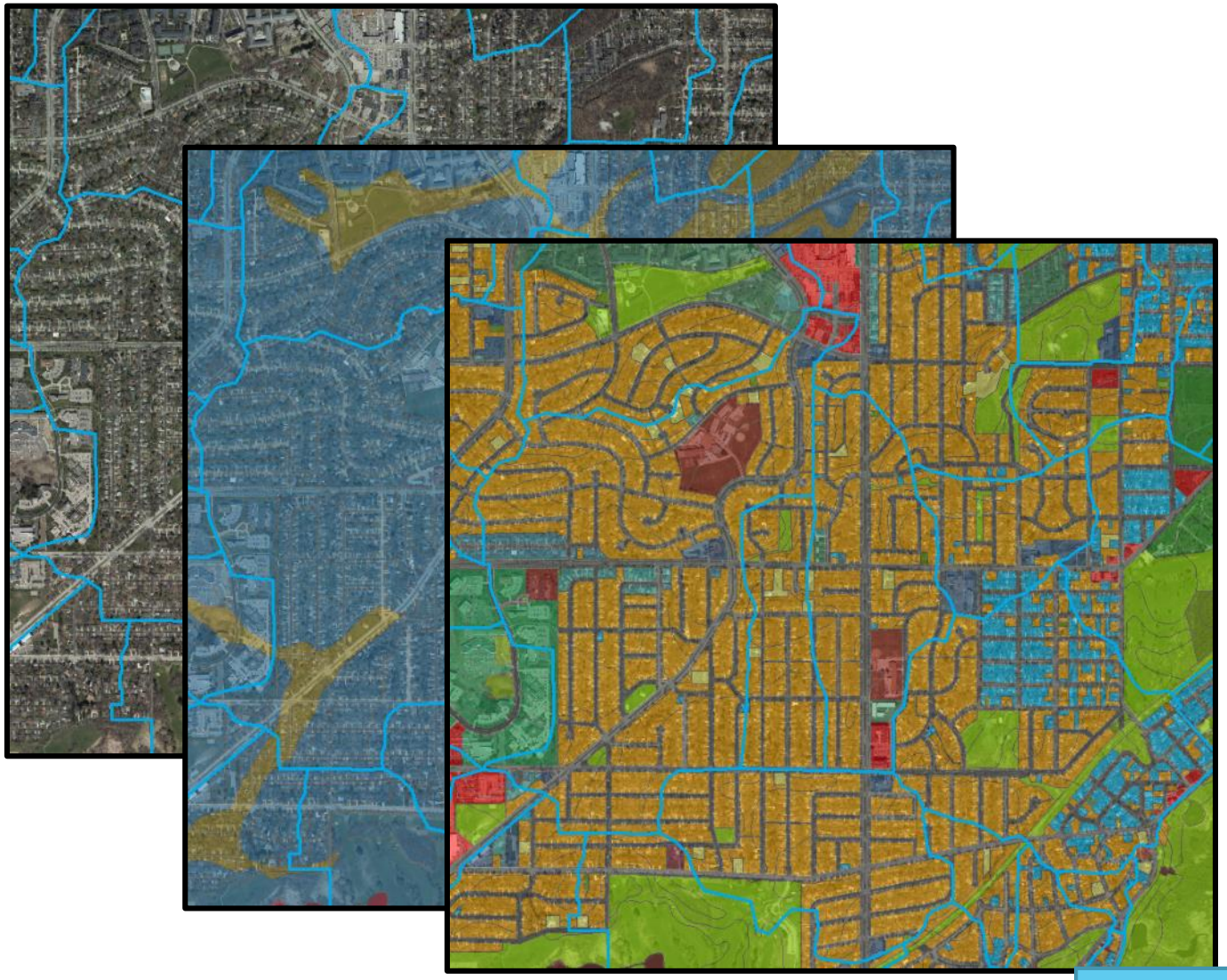
- Wet and dry detention ponds
- Infiltration basins
- Rain gardens/bioretention facilities
- Catchbasins
- Coanda screen structures
- Street sweeping



tershed/Model

- Node maximum: 256
- 11 watersheds in City
- Two approaches used to delineate basins/models:
  - City of Madison outfall basins (based on 36” pipe)
  - Treatment device basins
- 60 models

WinSLAMM Input File Creation



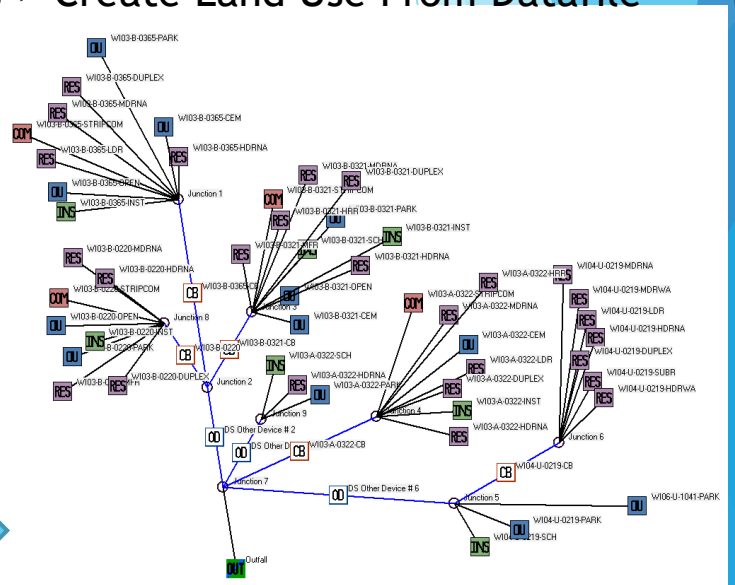
Intersected

- Outfall Basins
- Soil Type
- Land Use
  - Land uses assigned to WinSLAMM standard land use designation
  - Street area distributed via weighted average

Grouped outfall basins by model

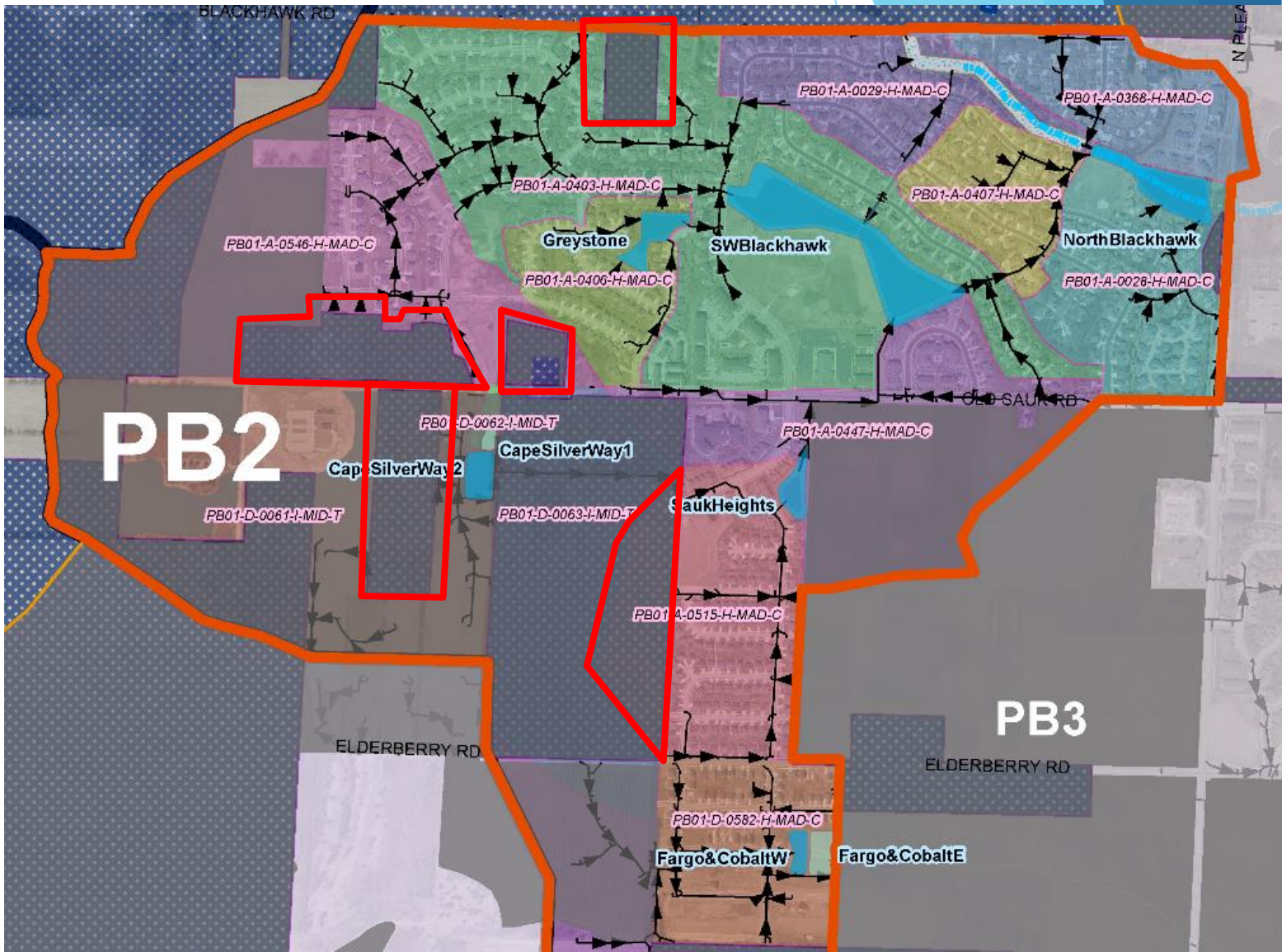
Created CSV

Tools-> Create Land Use From Datafile



Modeling Approach: Exempt Areas

- Exempt areas
  - Freeways (state/county)
  - Out of Madison areas (Town of Middleton, City of Fitchburg, etc.)
  - Areas zoned for and in use as agricultural
- Water must be routed, but Madison was not responsible/could not take credit for pollutant load
- Solution: Other Device



Program Options

Detailed Output File Options | **Default Model Options** | Default Current File Data

Default Monthly Stormwater Temperature (degrees F)

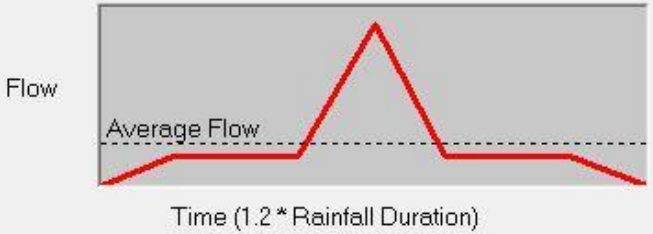
January	40
February	45
March	50
April	55
May	60
June	65
July	65
August	60
September	50
October	40
November	35
December	35

- [ ] Turn 'Save File Upon Exit' Message Off
- [ ] Suppress the Wet Detention Pond Overflow Warning Message
- [x] Save Backup File
- [ ] Save Outfall Runoff and Particulate Loading for WinDETPOND Analysis

Maximum allowable biofilter surface ponding duration (hrs): 72

- [x] If Other Device pollutant load reduction values are set to 1, remove off-site pollutant loads from pollutant load percent reduction calculations.

Default Peak Flow to Average Flow Ratio: 3.8



Standard Land Use File: C:\WinSLAMM Files\StandardLandUses.000

- [x] Route Hydrographs and Particle Sizes Between Control Practices
  - [ ] Create Hydrograph and Particle Size Distribution .csv Files
- [x] Use Default Time Increment for all Hydrograph Analyses (required for hydrograph routing between control practices)

Default Time Increment (min): 6

Soil Compaction Infiltration Factors

	Sandy	Silty	Clayey
Moderately Compacted	0.50	0.20	0.10
Severely Compacted	0.20	0.10	0.00

File Update Options | **Cancel Changes** | **Save .INI File**

(fraction): 1.0000

action): 1.0000

vards the overall drainage calculation, uncheck the 'If ue is set to 1, remove off-site nt reduction calculation' b of the Tool/Programs

on): 0.0000

er Control (0-1): 1.0000

Press 'F1' for Additional Help

Paste Other Device Data

Delete Control

Continue

Modeling Approach: Leaf Management

- Interim Municipal Phosphorus Reduction Credit for Leaf Management Programs
  - Released Oct 5, 2017 by WDNR
  - 17% TP reduction granted in Medium Density Residential areas that meet particular leaf management and canopy cover requirements
  - Reduction only granted if treated area does not drain to other treatment practices
- Madison USGS leaf study suggests that most TP from leaves is dissolved
  - Ponds/catchbasins remove particulate phosphorus
- City of Madison and WDNR agreed on 8.5% TP reduction for Medium Density Residential areas that meet interim guidance requirements
  - Reduction applied on the back end (spreadsheet method)

Results: Total Suspended Solids (TSS)

Watershed	Area (ac)	TSS Yield - No Controls (lbs)	TSS Yield - With Controls (lbs)	TSS Reduction (lbs)	TSS Reduction (%)
Badger Mill Creek	7,293	1,314,739	517,557	797,182	60.6%
Door Creek	2,307	255,749	132,401	123,348	48.2%
Lake Mendota	6,464	1,815,636	1,318,174	497,462	27.4%
Lake Monona	4,061	1,343,426	1,010,452	332,974	24.8%
Nine Springs Creek	2,149	481,904	373,904	108,000	22.4%
Pheasant Branch Creek	3,250	641,340	261,806	379,534	59.2%
Pennito Creek	5,520	1,054,499	612,587	441,912	41.9%
Starkweather Creek	10,801	2,651,707	2,109,473	542,234	20.4%
Upper Yahara	1,222	228,516	140,469	88,047	38.5%
Lake Waubesa	507	127,078	94,686	32,392	25.5%
Lake Wingra	4,917	1,132,010	644,221	487,788	43.1%
Koshkonong	186	1,653	13	1,640	99.2%
Total	**48,678**	**11,048,256**	**7,215,744**	**3,832,512**	**34.7%**

Results: Total Phosphorus (TP)

Watershed	Area (ac)	TP Yield - No Controls (lbs)	TP Yield - With Controls (lbs)	TP Reduction (lbs)	TP Reduction (%)
Badger Mill Creek	7,293	5,049	2,943	2,106	41.7%
Door Creek	2,307	1,112	796	316	28.5%
Lake Mendota	6,464	6,101	4,985	1,116	18.3%
Lake Monona	4,061	4,094	3,430	664	16.2%
Nine Springs Creek	2,149	1,560	1,343	217	13.9%
Pheasant Branch Creek	3,250	2,066	1,086	980	47.4%
Pennito Creek	5,520	3,354	2,398	955	28.5%
Starkweather Creek	10,801	8,241	7,059	1,182	14.3%
Upper Yahara	1,222	923	689	235	25.4%
Lake Waubesa	507	422	340	82	19.4%
Lake Wingra	4,917	3,879	2,731	1,148	29.6%
Koshkonong	186	7	2	5	73.8%
Total	**48,678**	**36,807**	**27,801**	**9,006**	**24.5%**

Results: Leaf Management TP Reductions

Watershed	TP Reduction (lbs)
Badger Mill Creek	44.8
Door Creek	0.5
Lake Mendota	86.6
Lake Monona	0.0
Lake Wingra	40.2
Nine Springs Creek	17.0
Pennito Creek	23.4
Pheasant Branch Creek	15.4
Starkweather Creek	53.2
Upper Yahara	21.1
Lake Waubesa	0.0
Koshkonong	0.0
Total	**302.1**

Limitations of the Modeling Effort

- No Waters of the State included in analysis
  - Not allowed for MS4 general permit, but…
  - City of Madison can take credit for Rock River TMDL
- No private treatment practices included
  - 830 private practices in the City of Madison
  - Limited documentation on practices
  - Treatment of small areas
  - Stability concerns with WinSLAMM
  - City is working with WDNR to develop a method to take credit for private practices for TMDL

Problems and Solutions: Street Sweeping

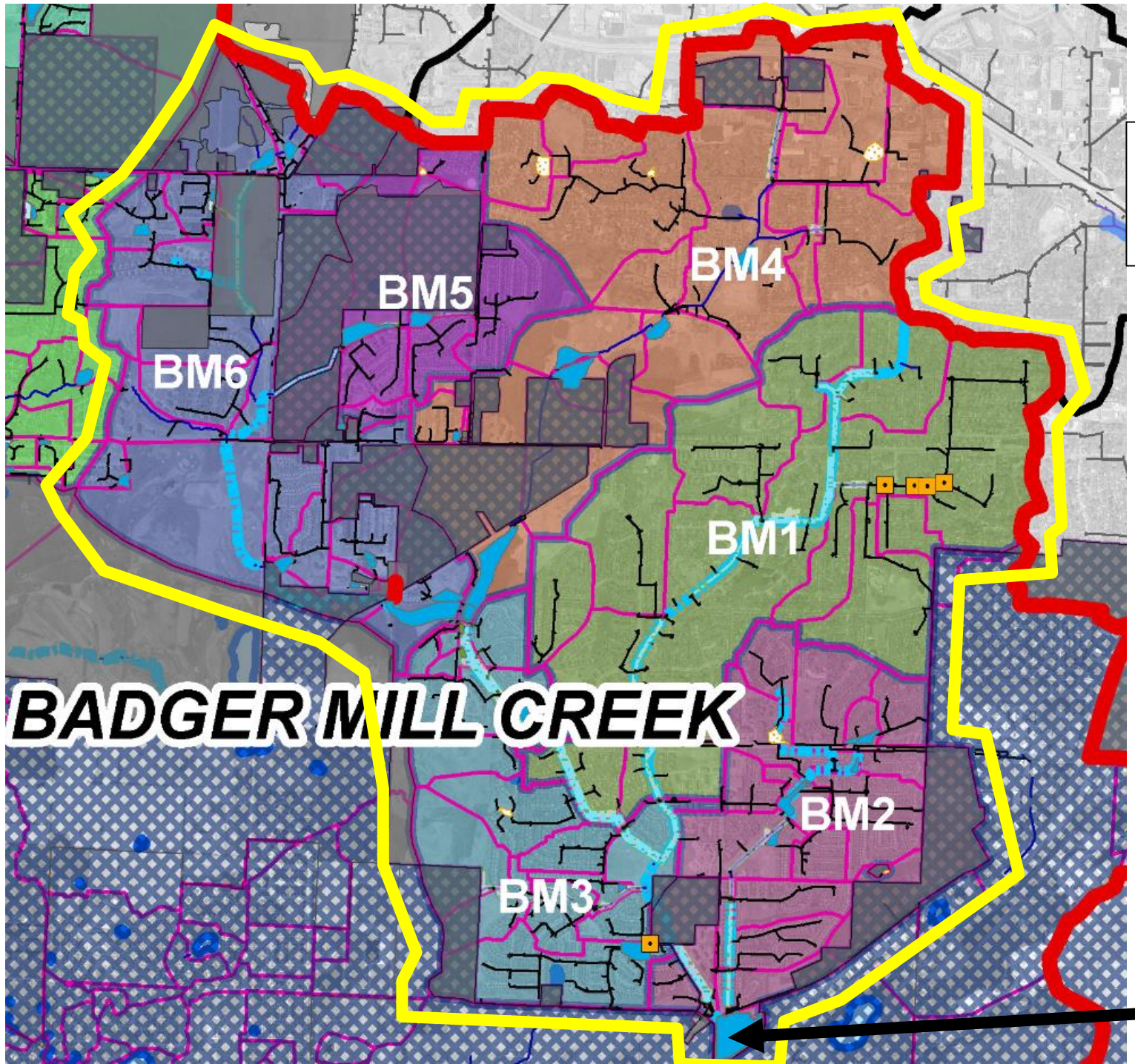
- City of Madison sweeps all city streets within municipal boundary
- Average frequency of sweeping: 1 time/month for May 1 – Nov 15
  - Isthmus/downtown: 1 time/week
- Restricted parking on most downtown streets
- Mechanical broom cleaner

Problems and Solutions: Street Sweeping

- Problem: each instance of street sweeping is associated with a single street land use, entered as an individual control practice
  - Multiple street sweeping instances can dramatically increase the size of a model
  - Large models cannot run the 5-year rainfall file required for weekly sweeping
- Solution 1 (areas with monthly sweeping): remove street sweeping from model, run 1-year rainfall file
  - Add in sweeping reductions on the “back end”
  - 3% TSS and 1.73% TP reduction from no controls
- Solution 2 (areas with weekly/mixed sweeping): split models as small as possible, run 5-year rainfall file
  - IF 5-year rainfall file will not run, split into five 1-year rainfall files and average results

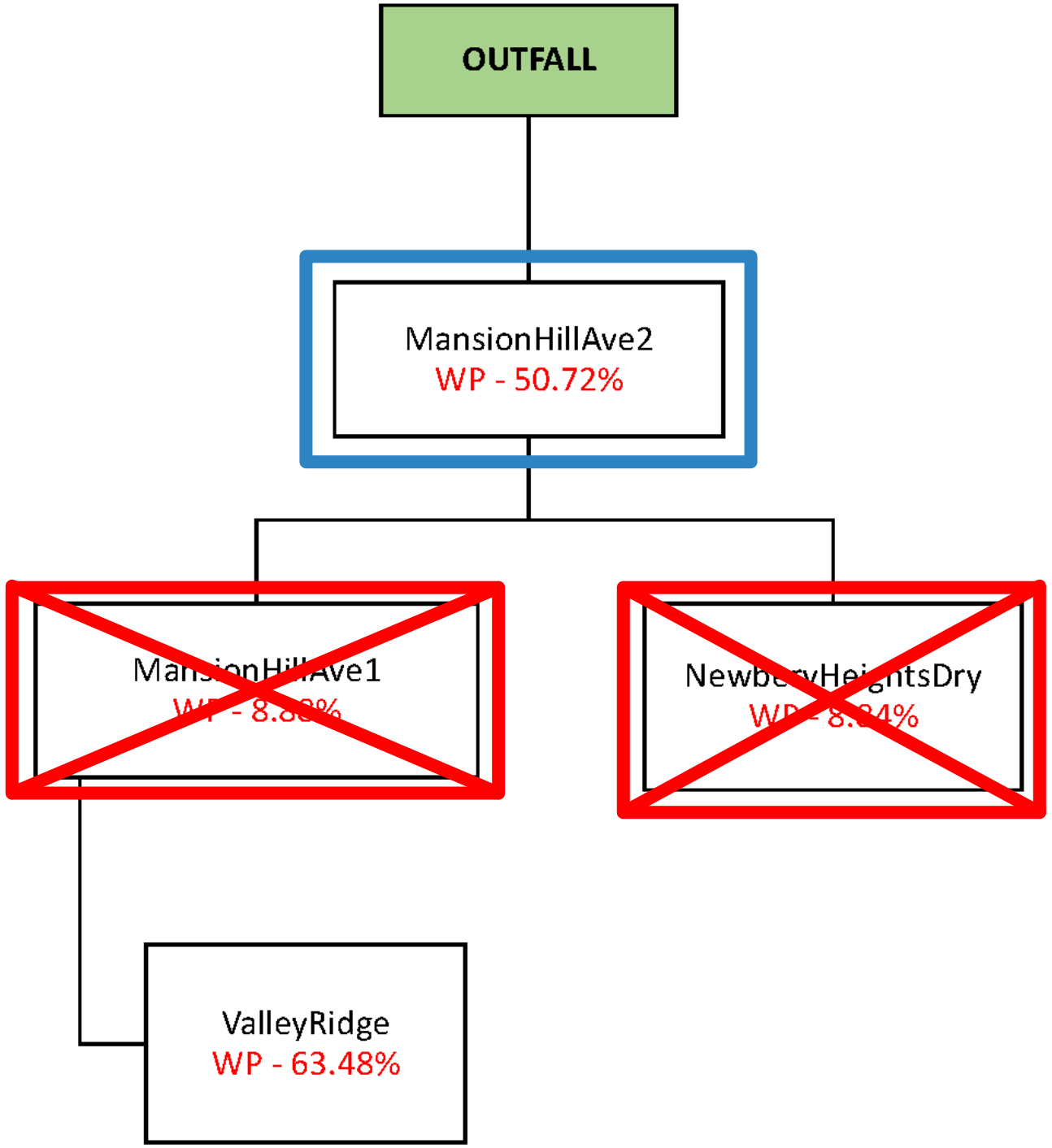
Problems and Solutions: Regional Detention Ponds

- Problem: regional detention ponds drain large areas with multiple upstream treatment devices



UBMC watershed
Contributing area = 5949 acres
No. of major treatment devices = 53

UBMC South Regional Pond



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Problems and Solutions: Regional Detention Ponds

- Problem: regional detention ponds drain large areas with multiple upstream treatment devices
- Solution: split large models
  - Break large models into a regional model (including regional pond) and contributing models
  - Condense contributing models into representative zero-load areas and route through regional model
    - Use Other Device with 100% particulate and filterable load reductions
  - Sum load reductions from contributing and regional models to obtain total reduction

Ultimate Solution: Outsourcing!

- Primary problem: models are too big
- Solution: model linkage
  - Export hydrograph/loading/particle size distribution curve from one model
  - Import exported information into a dummy land use in another model
- No plans to implement in upcoming WinSLAMM additions
- City of Madison contracting with PV Associates to develop this capability in new edition of WinSLAMM (late 2018/2019?)

Questions?